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Geology

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In 1830, five chapters into his epoch-making *Principles of Geology* (1830-3), Charles Lyell invited his readers to imagine a descent into the underworld conducted by a gnome. 'A being, entirely confined to the nether world' (1:82), Lyell's gnome is a '"dusky melancholy sprite", like Umbriel', the gnome who travels to the depths of the Cave of Spleen (located in the heroine's abdomen) in Alexander Pope's mock-epic poem *The Rape of the Lock* (1714). Not Umbriel, but like him, Lyell's gnome is 'never permitted to "sully the fair face of light", and emerge into the regions of water and of air', trapped beneath the rocks and unable to see all the many kinds of geological change operating on the earth's surface or beneath the rivers and sea. The gnome cannot see erosion and weathering, for instance, which mainly affect the rocks on the earth's surface; nor can he see the deposition of the strata beneath the sea. Such a gnome, Lyell tells his readers, might 'busy himself in investigating the structure of the globe' and attempt to turn geologist. But if he did, he would probably 'frame theories the exact converse of those usually adopted by human philosophers'.

Examining the subterranean world from within, then, the geologist-gnome would only be able to see layers of rock descending from the surface of the earth ever-deeper towards its centre. Near the surface, those rocks would be neatly layered and full of shells and fossils – evidence that plant and animal life had been abundant when those rocks were formed. As the rocks got deeper, they would contain fewer and fewer fossils, and the layers become less obvious. At the bottom of the pile, the rocks would not be layered at all, but would exist as masses of granite and basalt shot through with metallic veins. Were the gnome to write a history of the earth

based on his observations, he would most likely conclude that ‘Every year the strata’ found at the top of the rock pile ‘get broken and shattered by earthquakes, or melted by volcanic fire’, ‘fused and crystallized’ until they turn into the granites and basalts of the deeps (1:82-3). At the dawn of the world, he would assume, all the rocks must have been layered in ‘curiously-bedded formations’ (the strata) (1:82), full of fossils. This primeval world must therefore have been more stable than the convulsive, volcano-and-earthquake-ridden present. For the gnome, trapped in the underground, the earth would seem to be getting hotter, and more violent. From his perspective, life would seem to be getting progressively harder to sustain on the earth: one day, he might surmise, ‘the whole globe shall be in a state of fluidity and incandescence’ (1:83).

Lyell’s gnome is designed to raise a smile, perhaps, and he occupies only a fleeting moment in the text. But he belongs to a rich literary and philosophical tradition of which Pope’s *The Rape of the Lock* is merely the most well-known example, and in which gnomes fulfilled a range of both serious and satiric purposes. In his ‘dedicatory epistle’, Pope cited *Le Comte de Gabalis* as his source, a book first written in 1670 by Abbé N. de Montfaucon de Villars, translated into English in 1680, and which satirised what Pope calls a poetic machinery ‘raised on a very new and odd foundation, the Rosicrucian doctrine of spirits’ (15). This ‘doctrine’, associated with a secret society called Rosicrucianism, was derived from the Renaissance philosopher and alchemist Paracelsus, who argued that Aristotle’s four ‘sublunary’ elements comprising the world beneath the heavens – fire, air, water, and earth – were tenanted by elemental beings: salamanders, sylphs, nymphs, and gnomes. Challenging long-held belief that all sublunary spirits were fallen angels, Paracelsus advocated the first-hand, empirical study of nature and suggested that elementals were embodiments of the invisible processes by which inanimate matter was made to move, think, breathe, and live. Though they were invisible, and therefore inaccessible to human observation, they were part of Paracelsus’s argument for the detailed

study of nature over adherence to received doctrine. This paradox was exploited by Villars in *Le Comte* to satiric ends, but many of its readers – including its English translators – missed the satire and took it for a serious exposition of a philosophical idea. Pope's Umbriel draws on this ambiguity, pretending to take *Le Comte* seriously in the 'dedicatory epistle' to the poem by poking fun at female readers who had thought it merely a novel (15), but having his gnome explain nothing about the natural world and journey to the centre of his victims' spleens instead of to the underworld of classical epic, where in comic mode he makes those victims pimply, red, suspicious, and sick (Canto 4, ll. 67-78). As such, Pope's 'Rosicrucian' machinery both deploys and pokes fun at supernatural explanations of physical processes (see Veenstra, and also Latimer).

It is tempting to say that this is the sense in which Lyell's gnome operates in *Principles of Geology*. Lyell regularly debunks superstitious explanations of natural events as 'delusion[s]' common to human beings who were 'in an early stage of advancement' (1:76), mocking those who wittingly – or even unwittingly – resorted to supernatural explanations of the earth's phenomena. And Lyell's gnome inhabits a nonsense world, a world turned upside down, framing 'theories the exact converse of those usually adopted by human philosophers'. But it is quickly revealed that the gnome's nonsense is not the opposite of human 'sense'. Instead, it is a mirror for the equal kinds of nonsense produced by the 'human philosophers' confined to the earth's surface.

To characterise this nonsense, Lyell had a specific 'theory' in mind: an account of earth history that had just been given elegant exposition in *Consolations in Travel; or, The Last Days of a Philosopher* (1830), written by the famous chemist and philosopher Humphry Davy. In this text, an even more mysterious figure than Lyell's gnome, a 'stranger' called 'The Unknown',

describes ‘the early changes and physical history of the globe’ (Davy 1830 132) in what he presents as chronological order:

> [T]he globe, in the first state in which the imagination can venture to consider it, was a fluid mass with an immense atmosphere revolving in space round the sun, and … by its cooling, a portion of its atmosphere was condensed in water which occupied a part of the surface. In this state, no forms of life, such as now belong to our system, could have inhabited it; and, I suppose the crystalline rocks, or as they are called by geologists, the primary rocks, which contain no vestiges of a former order of things, were the results of the first consolidation on its surface.
>
> (134)

Here, the ‘primary’ rocks – those masses of basalts and granite found at the bottom of the rock sequence – were considered the *first* rocks formed in the history of the earth. They were not fossiliferous, because the earth had been too hot to support life in this period. As it cooled, the Unknown continues, ‘depositions took place, shell fish and coral insects of the first creation began their labours; and islands appeared in the midst of the ocean raised from the deep by the productive energies of millions of zoophytes’ (Davy 1830 134). Palms and tropical plants ‘similar to those which now exist in the hottest parts of the world’ covered the globe, and fish and shell fish swam in the tropical seas. Sands were agglutinated from the cooling of the early globe’s molten fluids, and the first ‘secondary’ rocks – rocks we now find layered in strata and filled with fossils – were laid down (Davy 1830 134-5). ‘[O]viparous reptiles’ succeeded fish and corals, ‘and the turtle, crocodile and various gigantic animals of the sauri kind seem to have haunted the bays and waters of the primitive lands’ (Davy 1830 135), lands violent and volcanic, in which ‘there was no order of events similar to the present’: mountains were thrown up and lands thrown down from the ocean with frequency and speed since the earth’s surface was so thin. Slowly, the earth became gentler, and capable of supporting more complex forms

of life, each leaving behind fossils in freshly laid layers of strata: ‘the mammoth, megalonix, megatherium and gigantic hyena’, all ‘now extinct’ (Davy 1830 136), superseded the reptiles as the eruptions and earthquakes grew fewer. There had been only one event in the earth’s recent past to recall the horrors of the primeval world, dragging ‘immense quantities of water, worn stones, gravel and sand’ (Davy 1830 136) across the earth. But generally the earth’s rate of change had slowed. When the ancient battle between fire and water was ‘no longer to be dreaded, the creation of man took place; and since that period there has been little alteration in the physical circumstances of the globe’ (Davy 1830 137).

Davy’s story, of an earth getting progressively cooler, able to support increasingly more complex forms of life until stable geological conditions heralded the coming of man, had (unlike the gnome’s ‘converse’ account), the advantage of being based upon three decades of European research into the history of the earth. In Britain this research was associated, at least in part, with the Geological Society of London, formed in 1807. The Society’s definition of ‘geology’ was as an empirical science based on fieldwork and devoted to the mapping of the strata, the collection of rocks and fossils, and the production of ‘columns’ and ‘sections’ – vertical images of the layers of sequences of rock in particular regions. This research programme was powerful and successful, spawning the so-called ‘heroic age of geology’, in which all the major subdivisions of the stratigraphic column were thrashed out (see Rudwick 1985, Secord 1986, Oldroyd, and Rudwick 2007 35-47).

In its early decades, this research had to be cautiously articulated. In the late eighteenth century, two rival theories of the earth had ruined reputations and caused fights and factions in the clubs of Edinburgh, one group arguing that the earth’s geological processes were primarily powered by fire, the other that its strata had been deposed from particles floating in a primordial ocean

that had once covered the entire globe (see Buckland 2013 33-40). By the early nineteenth century, these high-level theories and the arguments they had generated were threatening to bring science into disrepute: further research had revealed contradictions in both arguments, suggesting that geological processes were more complex than a single law (based on 'fire' or 'water') could explain. And controversy did little to inspire confidence in the authority of science. Furthermore, geology was contentious for other reasons, too. By 1800, many geologists believed that the earth was millions of years old, but other groups – including those who interpreted the Bible literally (by no means everybody who believed in the Gospels) – considered it merely a few thousand years old, suggesting that the new 'geology' flatly contradicted the Bible. Others argued that the Hebrew word for 'day' in the account of God's six-day Creation was metaphorical, and could be stretched to include millions of years; still others that a 'gap' filled with geological aeons sat between verse 1 of Genesis – 'In the beginning God created the heavens and the earth' – and verse 2 – 'the earth was without form and void' (King James Bible). Many elite men of science at the Geological Society interpreted the puzzling boulders that had been dragged for miles across the earth away from the strata to which they belonged by reference to Noah's Flood, which offered the closest match in the historical records to the event that might have produced such phenomena (see O'Connor 2007B). But by the 1830s, other explanations were becoming more convincing – Davy's Unknown suggests, for instance, that the 'immense quantities of water, worn stones, gravel and sand' (137) strewn across the earth's surface were attributable not to Noah's Flood, but to the creation of a new continent south of the equator. In the years following the publication of Lyell's *Principles of Geology*, several leading geologists would publicly 'recant' their earlier belief in Noah's Flood as a geological event recorded in the earth's strata, but none of them, including Lyell, lost their faith in a world created by God (see Rudwick 2009 73-88).

Nonetheless, geology did suggest a wide variety of troubling views of Creation, and of the fit between the scriptural and natural accounts of the world's construction and purpose.

Furthermore, in nineteenth-century Britain the study of rocks and fossils was widely associated with the scientific culture of pre-revolutionary France, with speculations that life was purely material. Another gnome-filled scientific poem employing Pope's 'Rosicrucian doctrine', written just as the French Revolution began, was Erasmus Darwin's *The Botanic Garden* (1791). This poem detailed the sex lives of the plants (in conventional, courtly, but erotic fashion), espoused anti-slavery and libertarian politics, and speculated on evolution. It was spectacularly successful: *The Botanic Garden* was perhaps the most widely-read poem of the 1790s. And unlike Pope's elemental beings, Darwin's had the unequivocally serious purpose of updating Paracelsus's elementals, who personified the invisible processes animating matter. For Darwin, the elementals were ancient 'hieroglyphs', allegorical representations of knowledge possessed by pre-literate societies, still useful to a modern poet seeking to 'visualize' invisible scientific processes such as those happening underground, 'and to attach them to concrete agencies as yet inaccessible to "rigorous" science', as Noah Heringman has put it (2004 223). Pope's gnomes allowed his readers – and men of science – to imagine processes that science had not yet observed. But in 1798 a parody of the poem, entitled *The Loves of the Triangles*, was published in a magazine called *The Anti-Jacobin Review*, making explicit the supposed connections between the poem's materialist explanations of physical processes, its sympathy with revolutionary politics, and its evolutionary musings. Darwin's reputation suffered a blow from which it has still not quite recovered. By the time Lyell – whose father was a botanist and literary critic – wrote *Principles,* Darwin's poetry and evolutionary speculations both lay outside the bounds of respectability. (On Darwin's geology,

see Heringman 2004 191-227; for detailed accounts of the *Anti-Jacobin Review* episode, see Priestman 193-216 and Fara 30-42).

Members of the Geological Society of London responded by focusing on empirical fieldwork, putting geology back in descriptive rather than speculative mode. Only once all the descriptions, maps, and specimens were collected and amassed could any generalised geological law or system emerge, they argued. Nonetheless, by around 1830, geologists began to relax their strict adherence to enumerative induction, to the simple accumulation of 'facts' of nature, and to attempt to add up all their observations of the strata in the hope of actually turning to reality the long-held ideal of *universal* stratigraphic column, an idealised column which would represent all the strata of the globe in a single image (see O'Connor 2009 and Laudan 537). The question was how to move between local observations to grander visions of the workings of nature without falling into the old traps: glossing over exceptions to the rule, oversimplifying the data, or implying an evolutionary narrative of life on earth. Tellingly, then, right before he tells the progressive story that was emerging from all this research, the Unknown in Davy's *Consolations* advocates caution. 'It is the general vice of philosophical systems', he states, with clear reference to the eighteenth-century theories geology had worked hard to leave behind:

> [T]hat they are usually founded upon a few facts, which they well explain, and are extended by the human fancy to all the phenomena of nature, to many of which they must be contradictory. The human intellectual powers are so feeble that they can with difficulty embrace a single series of phenomena, and they consequently must fail when extended to the whole of nature.
>
> (Davy 1830 131)

This might seem a strange caveat given that we have just ranged with a mysterious figure whose identity is never disclosed to us over the entire history of the globe. As Jan Golinski writes, 'the Unknown was conceived as an unworldly, even otherworldly, being, not so much a flesh-and-blood person as a spirit or angel temporarily assuming human form' (2013 11), allowing him to authoritatively claim the reality 'of intellectual or spiritual life continuing beyond the death of the material body'. He also bears an uncanny resemblance to the 'Genius' of the first dialogue of *Consolations in Travel*, who appears to the protagonist in a vision and guides him through the solar system to the rings of Saturn, revealing myriads of celestial beings inhabiting the universe beyond earth – each increasingly intelligent, less dependent on the clumsy physical senses on which human beings depend in order to acquire knowledge, and closer to the angels and to God (Davy 1830 1-60). Together, the Unknown and the Genius offer radical shifts in perspective that argue for man's spiritual existence, and also enable temporary moments of transcendence over his inherently 'feeble' 'intellectual powers' in order to articulate wider visions of the nature of creation and its history, to consider the span of geological time beyond human history and to range into unseen depths of the universe. It is not quite that they, like Darwin's gnomes, help us visualise the unseen. It is rather that they help replace limited powers of human *sight*, and the inductive scientific method which relied upon it, with *vision*: the Unknown can attain a visionary perspective on creation that lies beyond the reach of those relying only on the evidence of their imperfect senses. In journeying with him, the human being can begin to imagine the mysteries of a universe the vast majority of which he cannot see or yet comprehend. (See Secord 2014 25-51 for an excellent account of Davy's *Consolations* and its visionary and imaginative appeal; for more on Davy's *Consolations* see Golinski 2013, Knight 172-84, and Lawrence 225-7).

Davy's *Consolations* was far from being the first Romantic literary text to imagine a voyage into space conducted by a mysterious spirit guide – Percy Bysse Shelley's *Queen Mab* (1813) had contained similar passages, for instance. Most importantly for Davy, just eight years before the publication of Davy's *Consolations*, Lord Byron had written the sensational closet drama *Cain* (1821), which recasts the story of Cain and Abel as a tragedy of human *un*knowing. Cain is unable to reconcile the world in which, as a fallen human being, he 'seem[s] nothing' (Act 2, Scene 2, l. 420), with the 'Thoughts that arise within me' of the immensity of Creation and of the omnipotence and eternity of God (Act 1, Scene 1, l. 177). Asking to 'Let me but / Be taught the mystery of my being' (Act 1, Scene 1, l. 320), Cain is taken on an interplanetary journey by Lucifer to understand the insignificance of the earth when seen from space, before travelling into the depths of Hades to see 'enormous creatures … / Resembling somewhat the wild inhabitants / Of the deep woods of the Earth … / … but ten-fold / In magnitude and terror' (Act 2, Scene 2, ll. 132-8), the spirits of creatures who now 'lie/ By myriads' (Act 2, Scene 2, ll. 143-4) in fossils beneath the earth's surface drawn from Byron's reading of the French comparative anatomist Georges Baron Cuvier. But Cain runs into problems. Firstly, his human mind cannot comprehend the immensity of the universe with which he is confronted, too dependent as it is on the limited evidence of his senses: 'thou canst not / Speak aught of knowledge which I would not know, / And do not thirst to know, and *bear a mind* / *To know*' (Act 1, Scene 1, ll. 246-9; my italics), he tells Lucifer. As Lucifer puts it, in terms that would later be echoed by Davy's 'Unknown', 'matter cannot / Comprehend spirit wholly – but 'tis something to know / There are such realms' (Act 2, Scene 2, ll. 169-71). But whereas for Davy's hero it truly is enough to know there are such realms, to prove that there are spirit worlds beyond these in which greater knowledge of the universe is made possible, this is both frightening and depressing for Cain. Lucifer cannot show him the secret of death or the nature of eternity – just myriad worlds piled up through space and time, each created only to be

destroyed. In ‘rage and fury against the inadequacy of his state to his conceptions’ (1922 5:470), as Byron later wrote, Cain kills his brother.

Davy’s journeys through geological time and across astronomical space, then, rewrite Cain’s tragedy as triumph. Scientific discovery precipitates Cain’s decline, reminding him both of his human insignificance in a universe of infinite age and size, and also of his human inability to see the eternal realms of God. But science only works in this way if we do not have faith that there are conditions of being that make knowledge of the eternal possible. For Davy, grasping the immensity of geological time is a *precursor* to comprehending worlds beyond human reach, science offering a new imaginative vista to the human imagination that marks a step forward in his intellectual and spiritual evolution.

The disturbed imagination

Lyell too was a fan of Byron’s poetry. He wrote Byronic verse as an undergraduate, and wrote to his father that he had spotted Byron rowing in his gondola while on holiday in Venice. He also quoted from Byron’s *Childe Harold’s Pilgrimage* twice in *Principles of Geology* (see Buckland 2013 94-6, 127-30). And he shares Byron’s more pessimistic view of ruin, both in the natural world and of the human capacity to comprehend it. And so, despite the emerging scientific consensus on which Davy’s progressionist vision was based, and despite the Unknown’s careful presentation of the relationship between a global geology and detailed local research, in Chapter 9 of the first volume of *Principles of Geology* Lyell took progressionist geology to task, through a special attack on Davy, whom he quotes at length. This chapter, entitled the ‘Theory of the Progressive Development of Organic Life’, begins by noting that there are a ‘very few exceptions’ (Lyell 1:147) to the general rule that simpler species were

found in the earliest strata, and more complex in the most recently-deposited rocks. While the carboniferous era contained hundreds of species of monocotyledonous plants (plants with only one cotyledon – a leaf-like part of the embryo of a plant), a handful of fossilised dicotyledonous (and therefore more complex) plants had been found there, Lyell informed his readers. Also recently discovered was 'a saurian' (a giant reptilian form) 'in the mountain limestone of Northumberland' (Lyell 1:129), appearing much earlier in the fossil record than it should according to the law of progress. 'These exceptions', Lyell claims, 'are as fatal to the doctrine of successive development as if they were a thousand' (1:147).

It did not matter that these exceptions to progress were few and far between, Lyell argued, for two reasons. The first was obvious: one species out of sequence ruined the whole pattern, making the appearance of progress an illusion – or, as the very nature of Davy's visionary prose revealed, a delusion. Secondly, Lyell claimed that it was almost incredible that *any* reptiles or mammals had been fossilised at all. Fossils had to withstand millions upon millions of years of pressure, heat, chemistry, and erosion, meaning that very few of them actually survived. So few fossils existed that it was madness to extrapolate a complete story of life on earth from their scanty remains.

Most importantly, the majority of the earth's strata had been formed under water, and only later risen from beneath the lakes, rivers, and seas. Lyell asked his readers to indulge their imaginations once again in order to grasp the implications of this point for any consideration of earth history. 'Suppose our mariners were to report', he wrote:

> [T]hat on sounding in the Indian ocean near some coral reefs, and at some distance from the land, they drew up on hooks attached to their line portions of a leopard, elephant, or tapir; should we not

> be sceptical as to the accuracy of their statements; and if we had no doubt of their veracity, might we not suspect them to be unskilful naturalists?
>
> (Lyell 1:149)

Lyell continued, 'Can we expect for a moment that when we have only succeeded amidst several thousand fragments of corals and shells, in finding a few bones of *aquatic* or *amphibious* animals, that we should meet with a single skeleton of an inhabitant of the land?' (1:149). Hardly any aquatic animals survived in fossils, and they lived and died in the water where the rocks were formed, multiplying their chances of preservation. If we would laugh at the naiveté (or suspect the honesty) of a fisherman who claimed to catch leopards in his nets, then surely we would laugh at the geologist who found fossilised mammals in the mostly aqueous strata?

Lyell went on in this passage to compare this kind of geologist unfavourably to Clarence from Shakespeare's *Richard III*, whose prophetic dream of his own death revealed to him 'in the slimy bottom of the deep, / A thousand fearful wrecks; / A thousand men, that fishes gnaw'd upon; / Wedges of gold, great anchors, heaps of pearl' (quoted in Lyell 1:149). 'Had he also beheld', Lyell continued:

> [A]mid "the dead bones that lay scatter'd by", the carcasses of lions, deer, and the other wild tenants of the forest and the plain, the fiction would have been deemed unworthy of the genius of Shakespeare. So daring a disregard of probability, so avowed a violation of analogy, would have been condemned as unpardonable even where the poet was painting those incongruous images which present themselves to a disturbed imagination during the visions of the night. But the cosmogonist is not amenable, even in his waking hours, to these laws of criticism; for he assumes either that the order of nature was formerly distinct, or that the globe was in a condition to which it can never again be reduced by changes which the existing laws of nature can bring about.

(1:149-50)

Now, the geologist who has seen in the rock and fossil record evidence of progression is suffering visions even wilder than those of Clarence – imprisoned, terrified, and dreaming. Even he would not have imagined lions and deer at the bottom of the sea. Lyell does not make the parallel explicit, but the first conversation of Davy's *Consolations*, featuring the spectral 'Genius' and his journey into space, also appears in a dream to the protagonist, who, like Clarence, knows himself to be dying. The connection between Davy's visionary elaboration of the widely held view of progress in the fossil record and Clarence's nightmare is easy to spot.

At the end of this passage Lyell slips from the specific claim that few species are preserved in the strata to a more general argument that 'the cosmogonist' (a heading under which Davy, and the entire category of 'human philosophers', are now subsumed) 'assumes … that the order of nature was formerly distinct' (1:150). The link between these two things might not be immediately obvious, but it is crucial. Looking for leopards at the bottom of the sea is too preposterous even for a dream. But looking for leopard-like creatures in the *fossil record* is only preposterous if you assume, as Lyell does, that the way the earth works now – the kinds of things that happen on earth and the power of individual geological events to create change – is the way it has *always* worked. As such, Lyell's central strategy in *Principles of Geology* was to suggest a new *methodology* for studying the past. Since human beings had not witnessed most of earth history, and the evidence they had with which to understand it was so incomplete, they would need to analyse 'causes *now* in operation' (my italics) – 'now' meaning 'within human history': geologists would analyse whatever they could see happening all around them every day, or which they had good evidence had happened within the short span of human history. Events in the earth's past could only be understood by analogy with the present – and

for the analogy to hold, the geologist would need to assume that the past and present were similar enough to be compared, that geological events had always been of the same type, and of the same intensity, as those currently operating. By contrast, the idea of geological progress assumed that conditions in the past had been radically different from those in the present (the earth had once been much hotter, more volatile, disasters operated on a global scale). In Davy's account, it has only been since 'the creation of man took place' that 'there has been little alteration in the physical circumstances of the globe'. For Lyell, this was pure guesswork, an incredible assumption based on unreliable evidence about the earliest history of the world.

Even more radically than Davy, Lyell emphasises the 'feeble' nature of human intellectual powers. And it is in this sense that Lyell invokes Pope's gnome in Chapter 5 of the first volume of *Principles*. The gnome is not the first fantastical creature Lyell asks his readers to imagine, but the last in a long passage in which Lyell has also unfavourably compared the human geologist to 'an amphibious being, who should possess our faculties' (1:82). This amphibian 'would more easily arrive at sound theoretical opinions in geology' than a human being, 'since he might behold, on the one hand, the decomposition of rocks in the atmosphere and the transportation of matter by running water; and, on the other, examine the deposition of sediment in the sea'. The amphibious being endowed with human intelligence sees *more* than the human being, because he can inhabit both air and water. But he cannot inhabit the depths of the earth, the 'rocks of subterranean origin' which are the sole province of the gnome. Sylph, nymph, gnome, salamander: each restricted to a single element, each is also restricted to a partial view of the earth and its workings. But the human, too, is trapped more hopelessly than the amphibian, just as hopelessly as the gnome.

The lesson of these imaginings for Lyell was clear: human beings were inadequate observers of the natural world, bound by their bodies to a small fraction of its surface, a tinier fraction of its depths, and an even tinier portion of its history. They could not rely on their senses alone for the conduct of good scientific work, since they simply could not see into the past or into the depths of the earth or the sea. Even worse, humans could barely even rely on themselves to remember their own inadequacy. Many of Lyell's contemporaries had long held that the earth was millions of years old, but Lyell believed they had not fully comprehended the implications of the earth's antiquity. They had not *imaginatively* grasped the ways in which such age meant that the kinds of causes they saw operating all around them were enough to explain the wholesale geological changes that had taken place on the earth during its past. While Davy might have used supernatural beings to acknowledge and yet overcome the limitations of human perspective, to transcend our fixed positions on earth and show us things we could not otherwise see, Lyell's gnome was an attempt to make his readers confront the reality of just how limited that position really is: an objective correlative not, as we might expect, for the unseen processes of the underground, but for the tragi-comedy of human perception.

Imagining geology anew

Geology was a fashionable, controversial, and exciting science in the nineteenth century, and its images and stories were a rich source of material for novelists and poets throughout that period. Literary critics have shown that Lyell's dramatic evocation of the power of minute causes to effect great change over a long enough span of time gave Alfred Tennyson a

framework for exploring patterns of grief in *In Memoriam* (1850).[1] As navvies and colliers dug deep into the earth to build canals, railways, and sewers, they revealed immense fossilized 'lizards' or prehistoric beasts, like the unwieldy megatherium who appears with regularity in William Makepeace Thackeray's fiction, or the megalosaurus who famously waddles up Holborn Hill in the first paragraph of Charles Dickens's 1853 novel *Bleak House*.[2] As other critics have revealed, geologists also described stranger, smaller primeval creatures, like the trilobite with whom Thomas Hardy's protagonist Henry Knight comes face to face when he falls off a cliff in the 1874 novel *Two on a Tower*, or found in May Kendall's poem 'The Lay of the Trilobite' (1885).[3] One of Lyell's most speculative arguments against progress in the fossil record – that if hotter conditions reappeared on the earth then it was not inconceivable that seemingly 'ancient' species like the iguanodon and the ichthyosaur might also live again – inspired a plot sequence in another novel playing fast and loose with the idea of geological progress, Arthur Conan Doyle's *The Lost World* (1912) (see Buckland 2013 (Chapter 5)). That novel ends with a pterodactyl flying around the streets of London. Periodical articles appealing to all kinds of 'ordinary' readers would exhort them to take hammer and sack and go collecting specimens and chiselling at rocks and cliff faces (or would gently satirise the people who actually did). And Charles Kingsley's novels *Yeast* (1848), *Alton Locke* (1850), and *Two Years Ago* (1853) have geologists for protagonists – an aristocrat, a working-class autodidact, and a middle-class scapegrace returned from the Australian gold diggings – representing the wide social range of participants in nineteenth-century geological fieldwork, collecting, and writing. Kingsley plots the last of these novels according to geological maps and columns: the novel's action takes place in the 'Devonian' strata of Devon, Wales, and the Eifel region in Germany;

[1] A wealth of scholarship exists on Tennyson and geology: see Dean, Armstrong, Tomko, Zimmerman, and Snyder.
[2] On Thackeray, see Dawson 2011 and Dawson 2013. On Dickens, see Buckland 2013 247-75 and Zimmerman (Chapter 5), and Dawson 2015.
[3] See Ingham's seminal essay, Radford, and also Buckland 2008.

it may also be the case that the developing sense of British regionality and of regional writing in the nineteenth century was shaped by the three-dimensional form of geological maps, each region lying on a rock that represented a block or blocks of time in the stratigraphic record. These examples (given more thorough treatment in Buckland 2013 131-220) form only a handful of the most famous of many literary engagements with the forms, ideas, practices, objects, and images of geological science in this period.

Literary critics, too, have been repeatedly drawn to the geological passages in nineteenth-century poetry and fiction. In this critical tradition, geology has been associated with two basic plot patterns in nineteenth-century fiction: Lyell's 'uniformitarianism' (taken roughly to mean gradual change over a long span of time, and linked to slow political reform and the gradually developing plots of some forms of realism); and 'catastrophism', typically linked with Lyell's geological colleagues or with natural theology, and with revolutionary change and the broad strokes of literary 'romance' of various kinds (see Shuttleworth 52, 81, Smith 257, 120-1, Beer 181, Cosslett 4-5, and Meckier 243-76 for examples). In *Novel Science*, I argue against this move (see especially Introduction and Chapters 3 and 6), for two reasons. Firstly, there were not two 'schools' of geologists. Most of Lyell's contemporaries at the Geological Society of London agreed that the earth was millions of years old, but disagreed that all geological events throughout earth history had operated at the same intensity as those now operating. Secondly, the tendency to view science as the purveyor of big 'ideas' or plot patterns tends to abstract it from the everyday practices, methods, instruments, and debates that made that science possible. Some recent literary accounts of geology have thought much harder about these practices and literary engagements with them in more detailed and compelling ways. To take a key example, Noah Heringman has demonstrated the ways in which geologists used the traditional literary genre of antiquarian local history to describe the historicity of rocks and landforms; he has also

detailed interrelationships between early geology and mineralogical tourism, travel literature, and Romantic conceptions of the sublime and the picturesque, revealing that literature shaped the descriptive and historical practices of geology as much as it was shaped by them. Ralph O'Connor, too, studies 'science *as* literature, rather than science *and* literature', emphasising that in the nineteenth century 'Much poetry, and still more prose fiction, continued to be valued for its factual content; equally, scientific writing continued to have an aesthetic dimension, both self-consciously and by default' (2007A 15). Most importantly, O'Connor reminds us that earth history was presented to its readers in a wide variety of textual forms, 'not only in scientific treatises, but also in pamphlets, magazine articles, epic poems, autobiographies, children's stories, travelogues, and sermons' (2007A 15-16).

This variety of textual forms and of practitioners of geology means that there is no clear-cut way to distinguish between 'scientific writing', poetry, prose fiction, and nonfiction in geological writing. Nor is there any clear-cut sense in which writing can be distinguished from geological practice: ordering and naming the rocks, taking notes in the field, corresponding with other geologists, and the writing and publishing of geological books and papers were fundamental activities for many geological practitioners, and were often shaped by the stories, narrative strategies, and attitudes of contemporary writers like Walter Scott and Lord Byron, as has been hinted at here. The sheer excitement surrounding geological discovery and the practice of fieldwork in the nineteenth century means that it is rich in evocative, beautiful, and challenging texts, many of which are still ripe for exploration by literary critics.

While this essay has concentrated on just two elite men of science, Humphry Davy and Charles Lyell, then, it has also attempted to demonstrate an important point about the nature of this kind of geological writing. As James A. Secord has recently shown, the 1820s and 1830s were

crucial decades in the history of publishing, as the invention of the steam press and the production of cheap paper transformed the availability of printed matter (2014 1-23). Scientific writers sought to take advantage of the new plethora of print in a variety of ways, and Davy and Lyell clearly sought to define geological writing as a prestigious mode of authorship as philosophical and imaginative as poetry. In this, the two men were far more alike than they first appear. Just as Lyell attributed superstitious belief to man 'in an early stage of advancement', for instance, Davy too wrote that mankind in 'a state of nature' was 'a creature of almost pure sensation', 'harassed by superstitious dreams' or left 'to the mercy of nature and the elements' (1839-40 2:318-19). And why was early man so superstitious? Because unlike modern, enlightened man, he had to rely only upon his fallible senses, the immediate impressions the world made upon him. 'How different is man', Davy continued, 'informed by the beneficence of the Deity, by science and the arts!' (1839-40 2:319). Without a powerful, imaginative, literary culture, of which science was a clear part, man could not grasp the deep structures and processes that made the world tick. His mind was only capable of what Davy's friend Samuel Taylor Coleridge called 'Fancy' (313): passively receiving information imprinted on and recorded by his mind, mechanically recalled, and giving him little insight into the workings of nature.[4]

For both Davy and Lyell, reinventing science as a literary mode of authorship, the answer to all this was the sophisticated human imagination. For Coleridge, imagination in its 'primary' form was 'the living Power and prime Agent of all human Perception … a repetition in the finite mind of the eternal act of creation in the infinite I AM' (313), a unifying and idealising 'mysterious power' creatively conceiving of the world in repetition of God's creative acts,

[4] For Davy as a poet, and for the relationships between Davy's writing and poetry, see Fullmer, Sharrock, Levere, Lawrence, and Ruston.

making sense of the world's deepest mysteries. As Davy put it, the gift of science offered precisely this kind of imaginative act – it had 'bestowed upon' mankind 'powers which may be called "creative"', so that he could 'modify and change the beings surrounding him, and by his experiments to interrogate nature with power' (1839-40 2:319). And Lyell, despite the fact that he was concluding his chapter on the critique of Davy and of geological progress, also claimed that science enabled an imaginative and creative engagement with the natural world in similarly Romantic terms. 'Although we are mere sojourners on the surface of the planet', he consoled his readers, quoting John Dryden's translation of Virgil's *Georgics*:

> [C]hained to a mere point in space, enduring but for a moment of time, the human mind is not only enabled to number worlds beyond the unassisted ken of mortal eye, but to trace the events of indefinite ages before the creation of our race, and is not even withheld from penetrating into the dark secrets of the ocean, or the interior of the solid globe; free, like the spirit which the poet described as animating the universe, "Thro' Heav'n, and Earth and Oceans depth he throws / His Influence round, and kindles as he goes".
>
> (Lyell 1:166)

Man could not observe these 'worlds' beyond 'mortal eye', these 'dark secrets' and inner spaces, but he could, if he worked hard enough and read his Lyell carefully, dare to imagine them. Astronomers, spiritualists, evolutionary theorists, and poets the century long would describe worlds beyond the ken of human observation, citing Lyell's method of analogy between the world you *can* see and the worlds you *can't* – those worlds so far in the past, so deep into space, so big, so small, or so inexplicable that human beings could not actually see them.[5] In order for Lyell to get his readers to reimagine the power minute causes might hold over millennia, then, he sought first and foremost to remind them of the profound imaginative

[5] See Buckland 2016.

challenges they had in apprehending anything about their place in the world, in history, or in the universe, with any kind of certainty – without ever losing commitment to the notion that human beings were special possessors of a powerful and God-given imagination which, rightly trained, could transcend the limited evidence of the senses to echo (though never to fully attain) something like an omniscient view. As this example demonstrates, nineteenth-century geology participated in a broad literary and philosophical discussion about what the imagination was, and what it was capable of. In doing so, geological writing depended upon imaginative literature for its inspiration and its claims to power and prestige, and existed as a beautiful, evocative, and challenging form of literature in its own right.

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